An Evaluation Methodology for Traffic Awareness Displays

Ames Research Center • Army/NASA Rotorcraft Division

Joe De Maio

Aeroflightdynamics Directorate (AMRDEC)

US Army Research, Development, and Engineering Command

Ames Research Center

Moffett Field, CA

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Background

- NASA initiative to increase air transportation capacity
- Non-interfering operations to areas other than main runways
- Pilots could require increased traffic information to maintain separation and avoid main runway approach
- Out-the-window traffic detection is a possible metric for how traffic awareness
- Target detection shown to improve when target location is cued, but the effect is not consistent

Objective

- Develop methodology to measure the effect of cockpit display of traffic information on pilots' traffic detection
- Methodological concerns include appropriate flight tasking, data collection procedure, media, and data analysis procedures

Method: Apparatus

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- Evaluation aircraft: U. S. Army OH-58C
- Traffic awareness system: B. F. Goodrich Skywatch®
- Per supplemental type certificate with supplemental calibration test
- Display: B. F. Goodrich Stormscope®
- Cockpit display recorded with D V camera
- N. California Approach Control radar recorded on analog video tape
- Pilots' traffic calls recorded by researcher in the back seat

Method: Apparatus

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Other traffic
no Mode C

Traffic Advisory

Other Traffic Mode C
R/C > +/- 500 fpm
Relative altitude

Stormscope® display of Skywatch® traffic information

Method: Evaluation Pilots

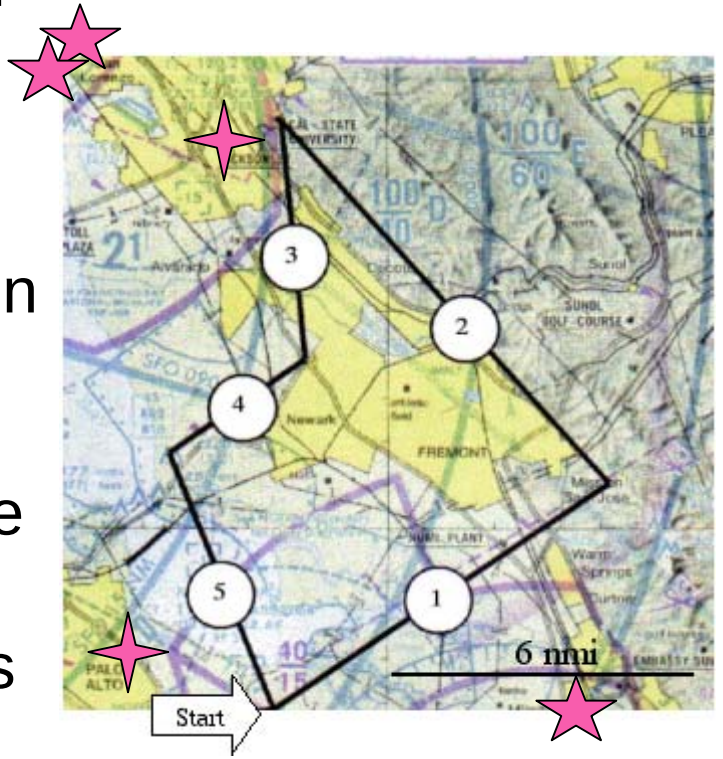
- Four, high-time pilots
  - Two in-house research pilots - system experience
  - Two outside pilots - no prior system experience
- All the pilots received a two-hour familiarization flight
- Two data collection flights per pilot, two-hours duration:

  with traffic awareness display

  without traffic awareness display

Method: Pilot Tasking

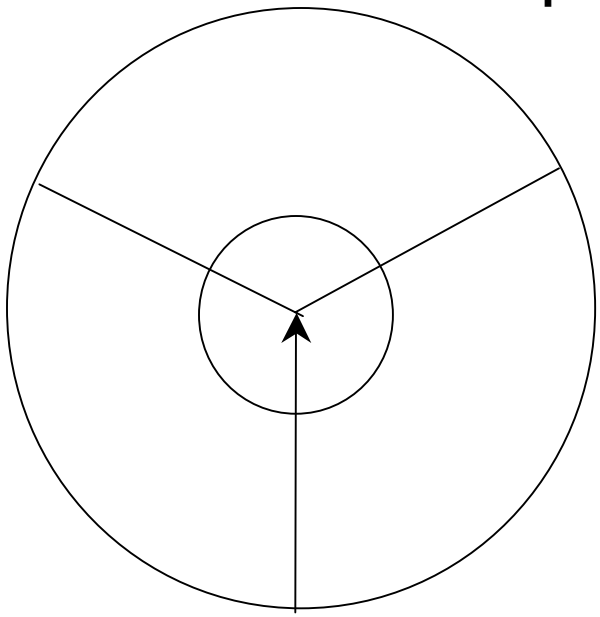
- Route: five legs, 1500 ft MSL, near airports and traffic
- Evaluation pilot's task to report all traffic visually acquired
- Safety pilot handled communication with air traffic control
- Evaluation pilot reported traffic range and bearing and whether the traffic was higher or lower
- All traffic to be reported as soon as it was seen
- Evaluation pilot gave ratings of workload and situation awareness following flight



Method: Subjective Data

Awareness Rating
1 = No Knowledge
7 = Full Knowledge

Value Rating
1 = No Value
7 = Critical Importance



Situation Awareness

Compared to my AVERAGE flight

Factors:

1) Workload associated with detecting and locating traffic

2) Workload associated with determining conflict status

3) Workload associated with selecting a course of action

Scale:

- **Much Below Average**
- **Somewhat Below Average**
- **Average**
- **Somewhat Above Average**
- **Much Above Average**

Workload

Results: Raw Traffic Counts

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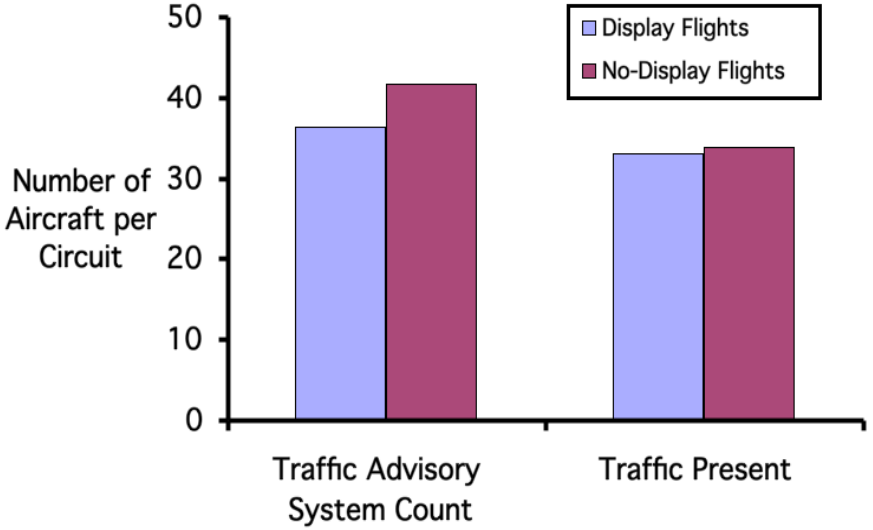

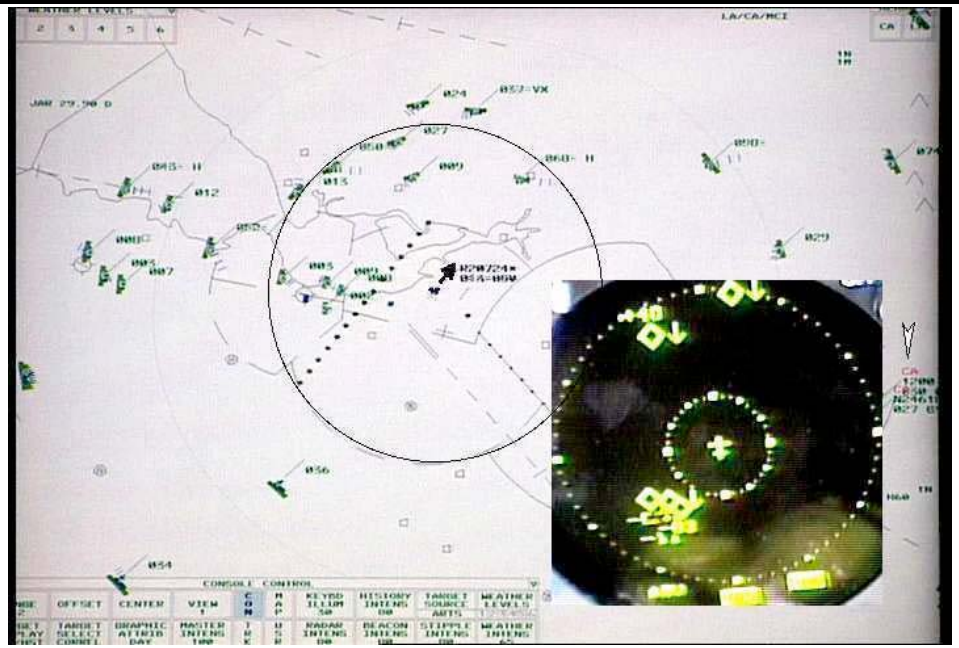

The count for the traffic awareness display was slightly larger than that for the tower

Technical issues:

- legibility and range of tower video
- scale change of tower video (first flights)
- discriminating targets on cockpit video

Results: Traffic Present vs. Pilot Traffic Reports

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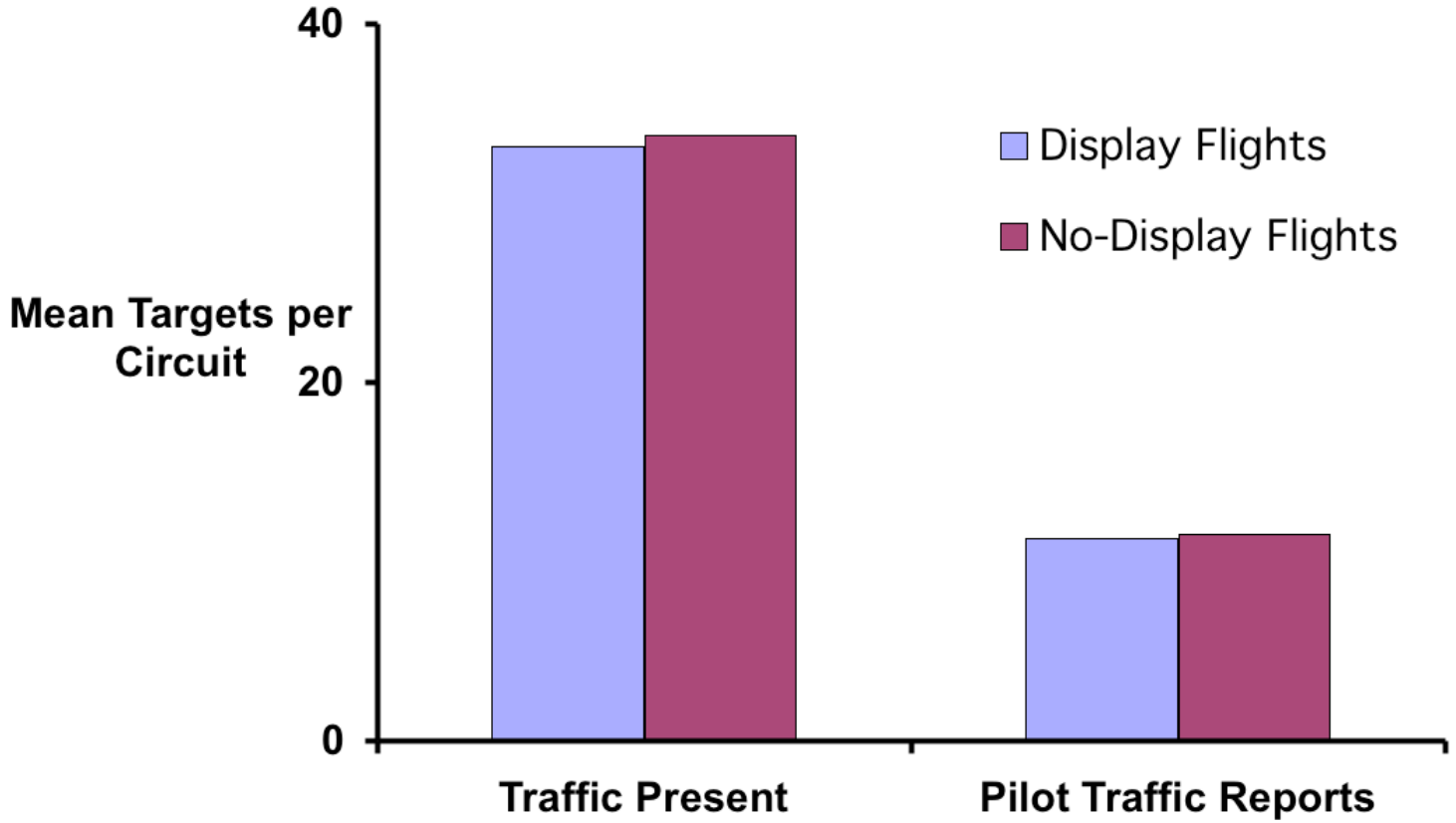

- Pilots reported about 35% of the traffic present
- Traffic advisory system did not improve performance

Results: Corresponding Tracks

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Analysis of corresponding tracks on the tower and cockpit recordings showed missed and mislocated traffic

Results: Corresponding Tracks

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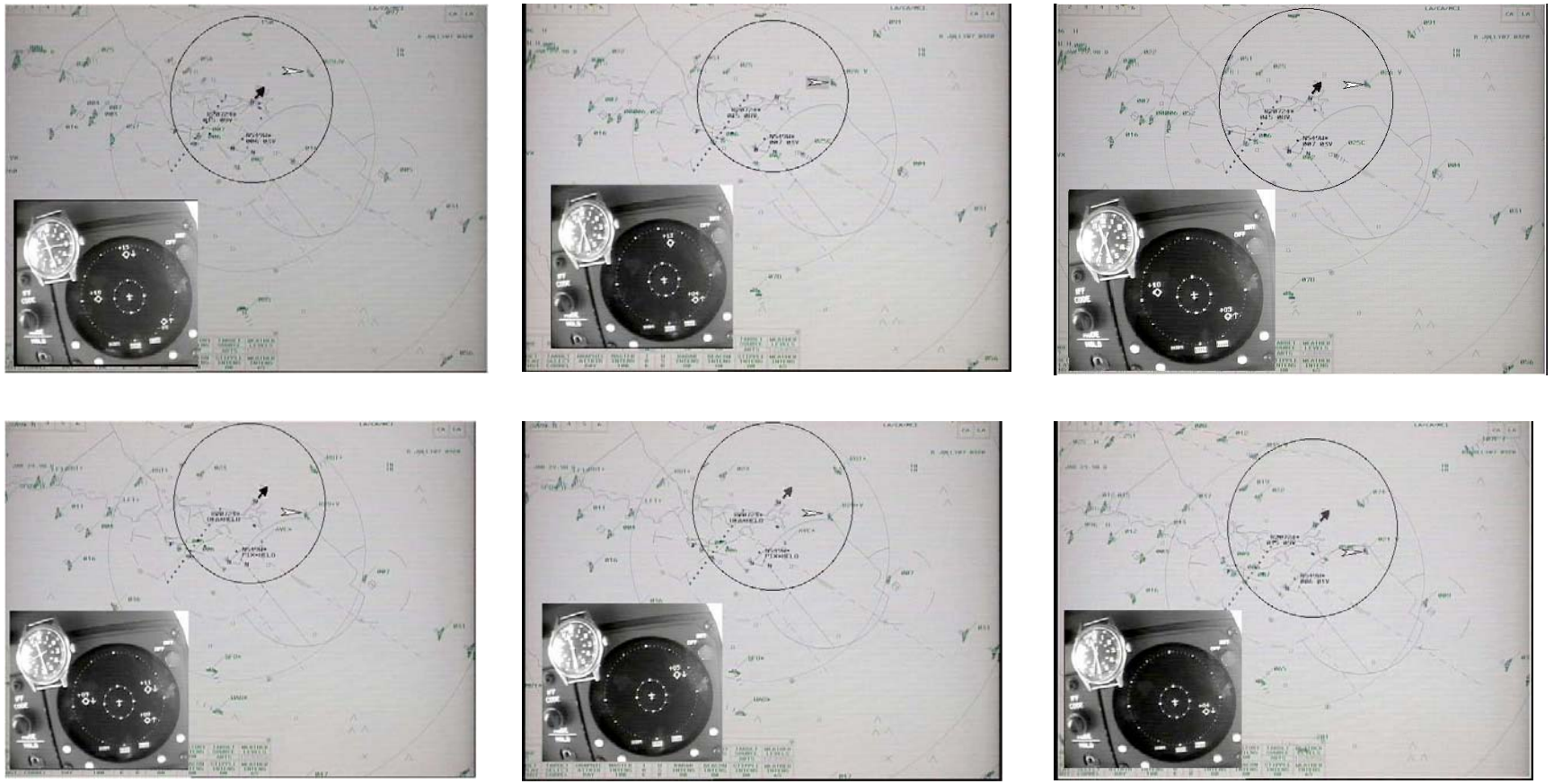

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Results: Situation Awareness

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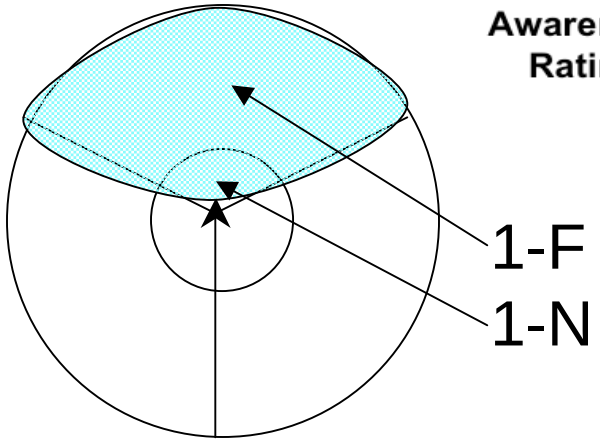
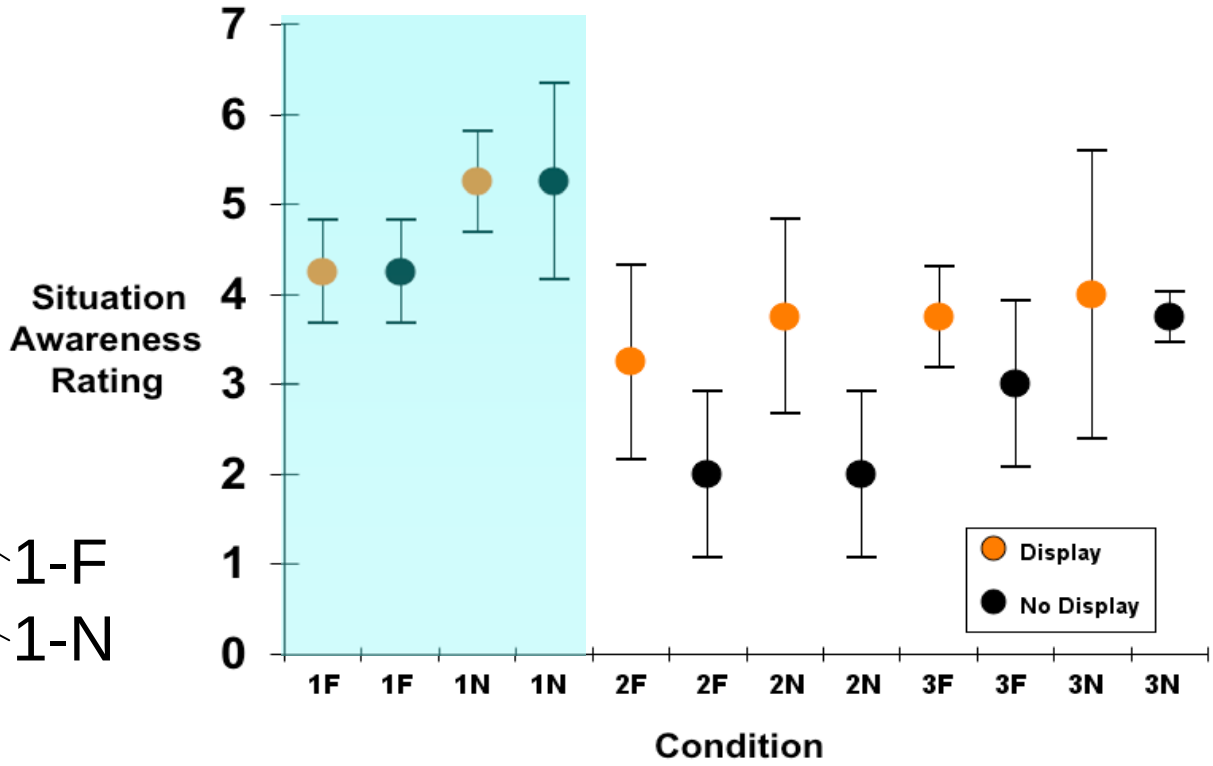
Sector Legend





- The pilots showed a tendency to feel that the traffic awareness display increased situation awareness, particularly on the left sector
- Value ratings were neutral for traffic information

Results: Situation Awareness

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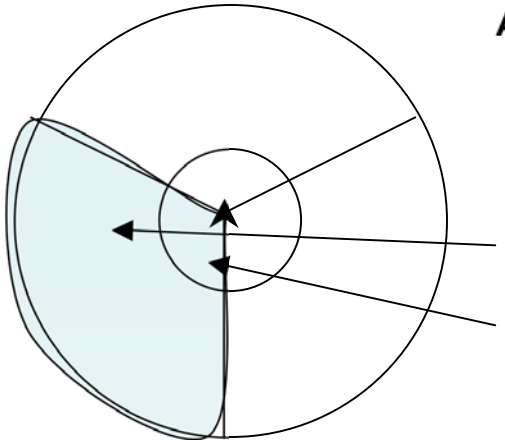

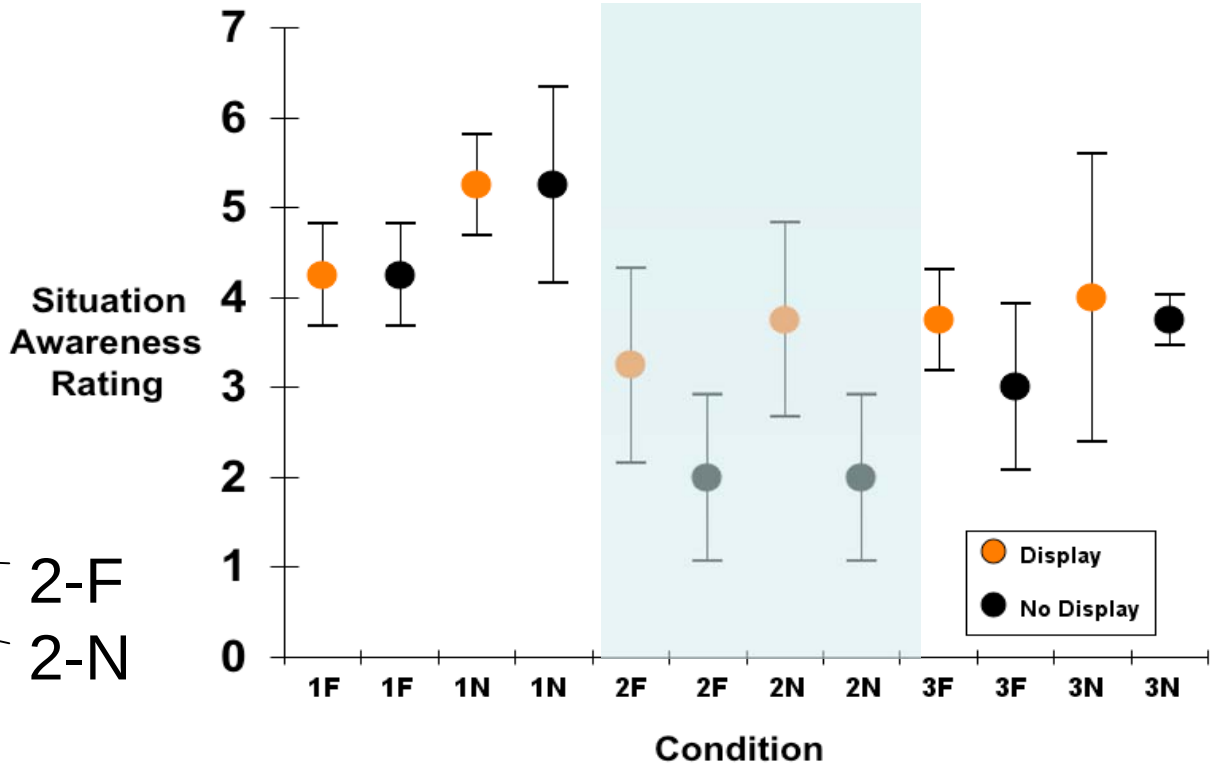

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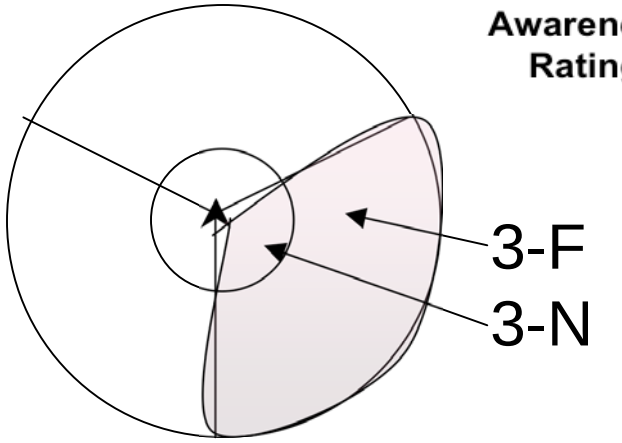

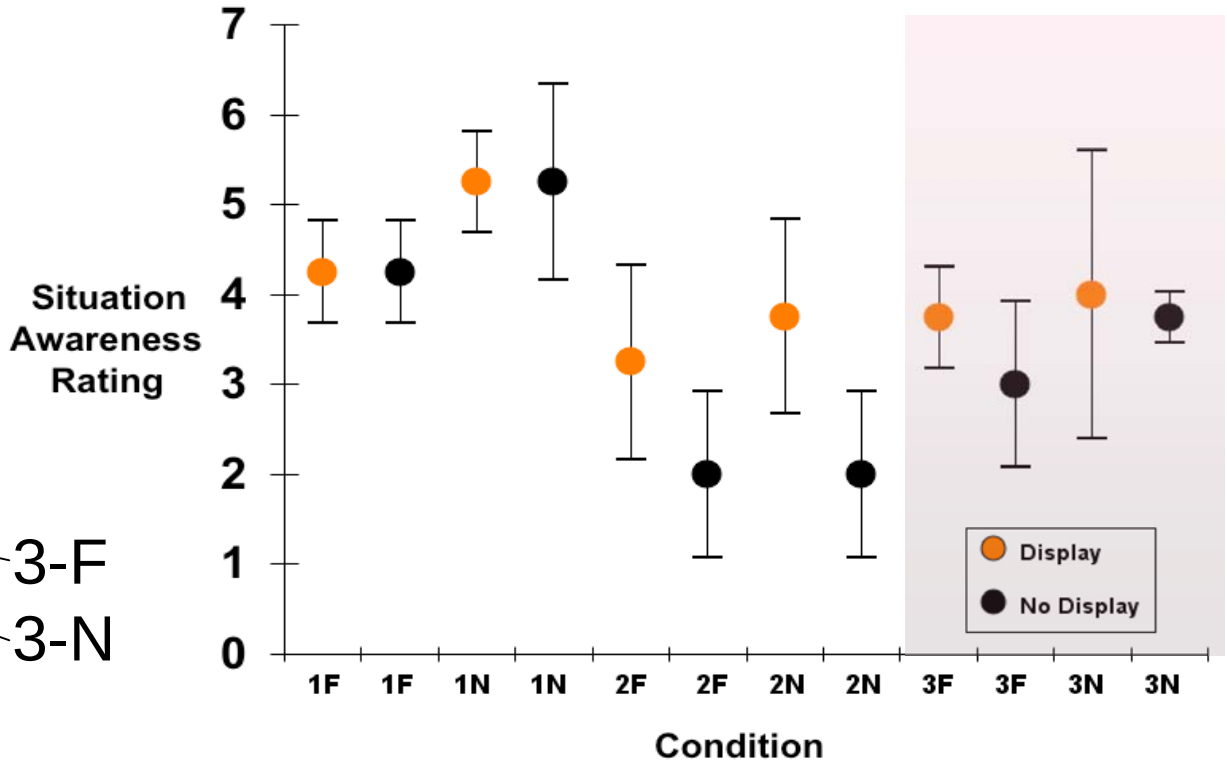

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Results: Workload

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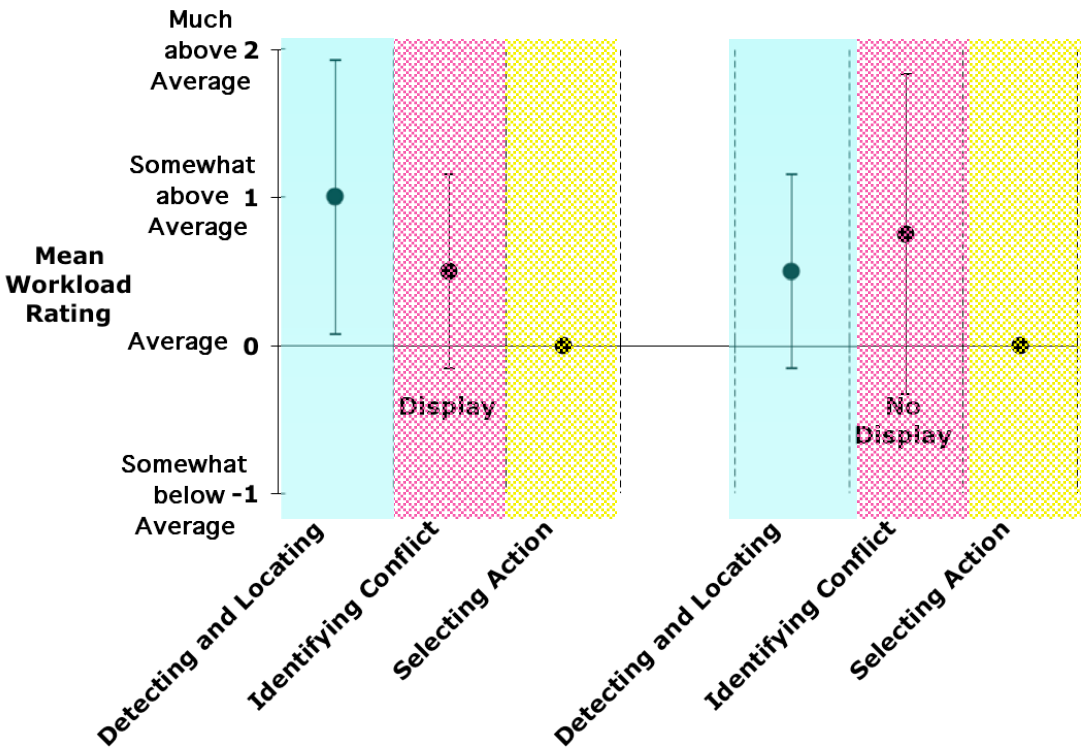

- The experimental task increased workload only slightly compared to an ordinary flight
- Using the traffic awareness display did not increase workload

Discussion

- Evaluation pilots did not visually locate more traffic with the traffic awareness system
- Unclear why pilot's detection performance failed to show the benefit of the system
- Possible explanation is that detecting traffic is less important than some form of risk awareness
- Occasionally a traffic advisory provided the pilot a first alert to traffic within two nautical miles

Summary and Conclusions

- A flight evaluation was conducted to develop a methodology for studying traffic awareness displays.
- The methodology supported measurement of out-the-window detection of traffic
- Traffic awareness information did not enhance traffic detection
- A traffic awareness display may provide a first alert when there is potentially conflicting traffic
- Situation awareness of hard to see areas is improved by a traffic awareness display
- Monitoring the display did not increase pilot workload

Related UAV Work

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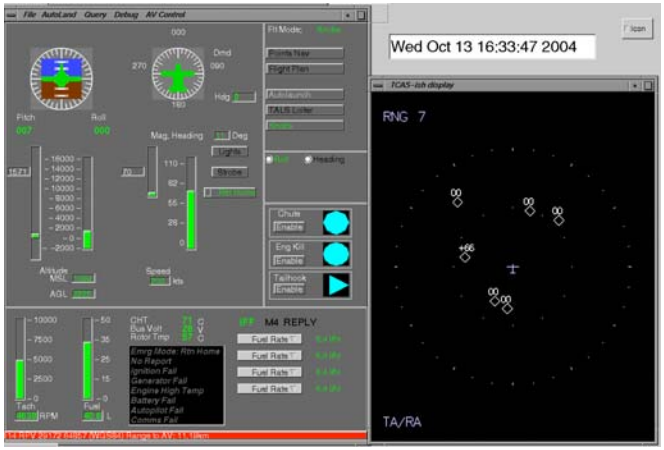
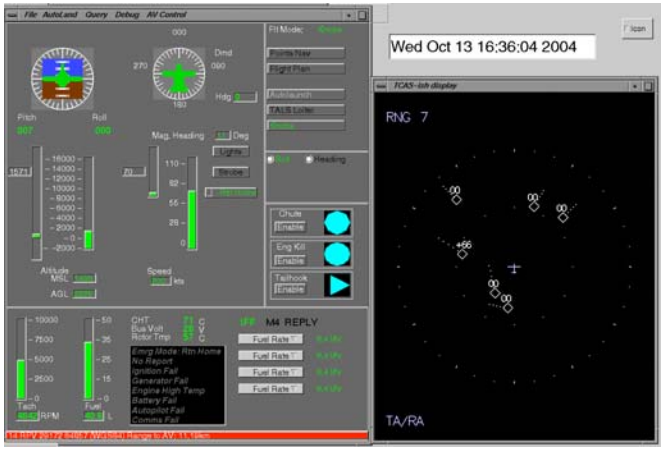
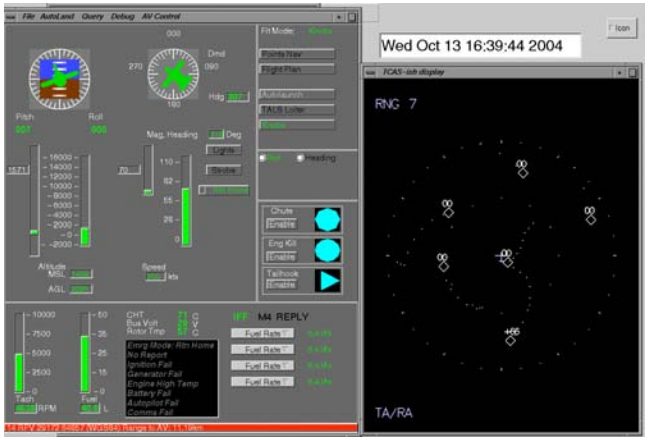
Base Traffic Symbols



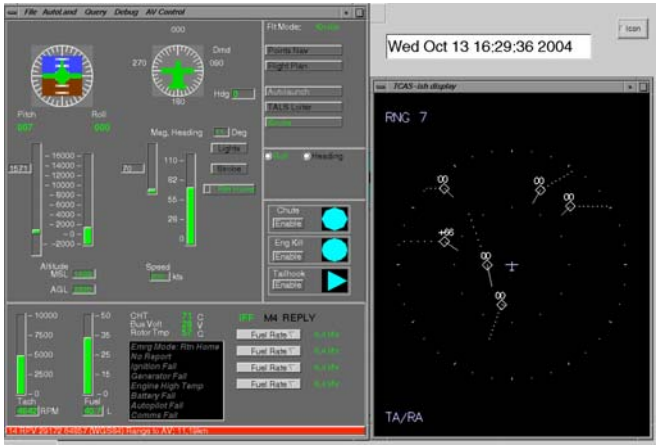
Relative Vector



Snail Trails



Ground Track



- Fast-time conflict detection task
- Detection further out with vector symbols

- Unnatural search technique
- Symbols effective for quick scan